

WHAT IS CLAIMED IS:

1. A perpendicular magnetic recording medium comprising a soft magnetic underlayer and a perpendicular recording layer which are deposited in this order over a substrate,

said soft magnetic underlayer comprising a first soft magnetic layer, a domain control layer which includes at least an anti-ferromagnetic layer, and a second soft magnetic layer,

wherein a ratio of said first soft magnetic layer thickness d_1 to said second soft magnetic layer thickness d_2 , d_1/d_2 falls within a range of 0.3 to 1.5, and

wherein, a magnetization curve of said soft magnetic underlayer, measured applying a magnetic field in a radial direction of the substrate, is shifted from the zero field axis along the direction of the magnetic field and coercivity H_c of the soft magnetic underlayer, which is obtained from the magnetization curve, is smaller than the exchange bias field (which corresponds to the shift from the zero field axis) H_{ex} .

2. The perpendicular magnetic recording medium as recited in claim 1, wherein the exchange bias field applied to said first soft magnetic layer H_{ex1} and the exchange bias field applied to said second soft magnetic layer H_{ex2} assume different values.

3. The perpendicular magnetic recording medium as recited in claim 1, wherein said anti-ferromagnetic layer thickness is between 5 nm and 40 nm.

5 4. The perpendicular magnetic recording medium as recited in claim 1, wherein at least one of said first soft magnetic layer and said second soft magnetic layer is made of a crystalline material.

10 5. The perpendicular magnetic recording medium as recited in claim 4, wherein said domain control layer includes one or two ferromagnetic layers and said two ferromagnetic layers are formed between said anti-ferromagnetic layer and the first soft magnetic layer
15 and between said anti-ferromagnetic layer and the second soft magnetic layer or said one ferromagnetic layer is formed between said anti-ferromagnetic layer and the first soft magnetic layer or the second soft magnetic layer.

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6. The perpendicular magnetic recording medium as recited in claim 1, wherein said first soft magnetic layer is made of an amorphous material.

25 7. The perpendicular magnetic recording medium as recited in claim 6, wherein said domain control layer includes a soft magnetic seed layer for controlling the orientation of magnetization of said anti-ferromagnetic

layer and said soft magnetic seed layer is formed between said first soft magnetic layer made of the amorphous material and said anti-ferromagnetic layer.

5 8. The perpendicular magnetic recording medium as recited in claim 6, wherein said domain control layer includes one or two ferromagnetic layers and said two ferromagnetic layers are formed between said anti-ferromagnetic layer and the first soft magnetic layer
10 and between said anti-ferromagnetic layer and the second soft magnetic layer or said one ferromagnetic layer is formed between said anti-ferromagnetic layer and the first soft magnetic layer or the second soft magnetic layer.

15 9. The perpendicular magnetic recording medium as recited in claim 1, wherein both the first soft magnetic layer thickness d_1 and the second soft magnetic layer thickness d_2 are between 25 nm and 150
20 nm.

10. A perpendicular magnetic recording medium comprising a soft magnetic underlayer and a perpendicular recording layer which are deposited in
25 this order over a substrate,
said soft magnetic underlayer comprising a first soft magnetic layer, a domain control layer which includes at least an anti-ferromagnetic layer, and a

second soft magnetic layer,

wherein a ratio of said first soft magnetic layer thickness d_1 to said second soft magnetic layer thickness d_2 , d_1/d_2 falls within a range of 0.3 to 1.5, and

wherein said domain control layer further includes one or two ferromagnetic layers and said two ferromagnetic layers are formed between said anti-ferromagnetic layer and the first soft magnetic layer and between said anti-ferromagnetic layer and the second soft magnetic layer or said one ferromagnetic layer is formed between said anti-ferromagnetic layer and the first soft magnetic layer or the second soft magnetic layer.

11. The perpendicular magnetic recording medium as recited in claim 10, wherein, in a magnetization curve of said soft magnetic underlayer, measured applying a magnetic field in a radial direction of the substrate, is shifted from zero field axis along the direction of the magnetic field and coercivity H_c of the soft magnetic underlayer, which is obtained from the magnetization curve, is smaller than the exchange bias field (which corresponds to the shift from zero field axis) H_{ex} .

12. The perpendicular magnetic recording medium as recited in claim 10, wherein both the first soft

magnetic layer thickness d1 and the second soft magnetic layer thickness d2 are between 25 nm and 150 nm.

- 5 13. A magnetic recording/reproducing apparatus comprising the perpendicular magnetic recording medium recited in any of claims 1 to 12, an actuator for rotating the perpendicular magnetic recording medium in a recording direction, a magnetic head equipped with a
10 read element and a write element, means for relatively moving the magnetic head with respect to said magnetic recording medium, and a read/write channel for inputting signals to said magnetic head and for recording output signals from the magnetic head,
15 wherein the read element of said magnetic head is composed of a high sensitivity element utilizing a magnetoresistive effect or a tunneling magnetoresistive effect.